CLAIMS

Having described the preferred embodiments, the invention is now claimed to be:

1. A magnetic resonance imaging method comprising:

dividing k-space **(100)** into a central region **(102)** disposed at k-space center and one or more annular surrounding regions **(104, 106)** having increasing distances from k-space center, the one or more annular surrounding regions including an outermost surrounding region **(106)** having a largest distance from k-space center;

acquiring k-space samples in the central region **(102)**;

subsequent to the acquiring of k-space samples in the central region, acquiring k-space samples in the one or more annular surrounding regions **(104, 106)**, the k-space samples in the outermost surrounding region **(106)** being acquired last, the acquiring of k-space samples in at least the outermost surrounding region using a row-by-row data acquisition ordering in which each row of k-space samples acquired in the outermost surrounding region, together with selected already-acquired k-space data from the regions other than the outermost surrounding region, forms a completed data set for reconstructing an image plane; and

reconstructing each completed data set into a reconstructed image plane without waiting for all k-space samples in the outermost surrounding region to be acquired such that the reconstructing occurs at least partially concurrently with the acquiring.

2. The method as set forth in claim 1, further comprising:

displaying each reconstructed image plane once it is available without waiting for the reconstructing of other image planes.

3. The method as set forth in claim 1, further comprising:

synchronizing the acquiring of k-space samples in the central region **(102)** with a trigger signal, the trigger signal being one of: (i) a selected duration after administering a magnetic contrast agent bolus, (ii) detecting a change in a magnetic resonance signal intensity due to wash-in of a magnetic contrast agent bolus, (iii) detecting a gating signal, and (iv) detecting a selected physiological event.

4. The method as set forth in claim 1, further comprising:

selecting a plurality of magnetic resonance imaging parameters for the acquiring of k-space samples in the central region (102) and in the one or more annular surrounding regions (104, 106), the plurality of magnetic resonance imaging parameters including at least a data acquisition rate; and

determining the central (102) region using (i) the selected plurality of magnetic resonance imaging parameters and (ii) a time interval (120) for the acquiring of k-space samples in the central region (102).

5. The method as set forth in claim 1, wherein the central region (102) has a round or oval perimeter, and the outermost surrounding region (106) has a round or oval inner perimeter and a square or rectangular outer perimeter.

6. The method as set forth in claim 1, wherein the acquiring of k-space samples in the central region (102) uses an acquisition ordering other than a row-by-row acquisition ordering.

7. The method as set forth in claim 6, wherein the acquiring of k-space samples in the central region (102) uses a random or pseudorandom ordering.

8. The method as set forth in claim 7, further comprising:

synchronizing the acquiring of k-space samples in the central region (102) with the administering of a magnetic contrast agent bolus.

9. The method as set forth in claim 6, further comprising:

sorting the k-space samples of the central region into a row-by-row ordering.

10. The method as set forth in claim 1, wherein the one or more annular surrounding regions (104, 106) include at least two surrounding regions, and the acquiring of k-space samples in the one or more annular surrounding regions other than the outermost surrounding region uses a random or pseudorandom ordering.

11. The method as set forth in claim 1, wherein the one or more annular surrounding regions (104, 106) include at least two surrounding regions, and the acquiring of k-space samples in every annular surrounding region including the outermost surrounding region uses a row-by-row acquisition ordering.

12. The method as set forth in claim 1, wherein each k-space sample (100) is a readout line of k-space.

13. The method as set forth in claim 1, wherein the acquiring of k-space samples in at least the outermost surrounding region using a row-by-row acquisition ordering includes:

acquiring the k-space samples using a serpentine row-by-row acquisition ordering.

14. The method as set forth in claim 1, wherein the acquiring of k-space samples in at least the outermost surrounding region using a row-by-row acquisition ordering includes:

applying secondary coordinate magnetic field gradients to traverse each row of k-space samples; and

switching to each new row of k-space samples by applying a primary coordinate magnetic field gradient, the primary coordinate being generally transverse to the secondary coordinate.

15. The method as set forth in claim 1, wherein the acquiring of k-space samples in at least the outermost surrounding region using a row-by-row acquisition ordering includes:

(i) acquiring a first row of k-space samples by traversing secondary coordinate positions in a positive direction at a first primary coordinate position;

(ii) applying a primary coordinate magnetic field gradient to move to a second primary coordinate position;

(iii) acquiring the second row of k-space samples by traversing secondary coordinate positions in a negative direction at the second primary coordinate position; and

(iv) repeating (i), (ii), and (iii) to acquire a plurality of rows of k-space samples indexed by the primary coordinate.

16. The method as set forth in claim **15**, wherein the primary coordinate is a slice coordinate, the secondary coordinate is a phase-encode coordinate orthogonal to the slice coordinate, and each k-space sample **(100)** is a readout line along a third coordinate orthogonal to both the slice and phase-encode coordinates.

17. The method as set forth in claim **1**, wherein the acquiring of k-space samples in at least the outermost surrounding region using a row-by-row acquisition ordering includes:

(i) acquiring a first contiguous portion k-space samples along a row within the outermost annular surrounding region;

(ii) skipping at least samples along the row contained in the central region;

(iii) acquiring a second contiguous portion k-space samples along the row within the outermost annular surrounding region, the second contiguous portion k-space samples along the row being separated from the first contiguous portion k-space samples along the row by at least the central region; and

repeating (i), (ii), and (iii) for each row of the row-by-row acquisition.

18. A magnetic resonance imaging apparatus comprising:

a magnetic resonance imaging scanner **(10)** imaging an associated imaging subject **(16)**;

a magnetic resonance imaging controller **(50)** performing a method including:

(i) dividing k-space **(100)** into a central region **(102)** disposed at k-space center and one or more annular surrounding regions **(104, 106)** having increasing distances from k-space center and including an outermost surrounding region **(106)** of largest distance from k-space center,

(ii) determining an optimum time for imaging a magnetic contrast agent bolus,

(iii) acquiring k-space samples in the central region **(102)** at about the optimum time, and

(iv) after acquiring the k-space samples in the central region, acquiring k-space samples in the one or more annular surrounding regions **(104, 106)**, the acquiring in at least the outermost surrounding region **(106)** using a plane-by-plane data acquisition ordering in which all k-space

samples in the outermost surrounding region belonging to a current k-space plane are acquired to complete the current k-space plane before samples in the outermost surrounding region belonging to other k-space planes are acquired; and

a reconstruction processor **(62)** that reconstructs the completed current k-space plane into a reconstructed plane image without waiting for other k-space planes to be completed.

19. The magnetic resonance imaging apparatus as set forth in claim **18**, wherein the acquiring of k-space samples in the central region **(102)** includes:

acquiring k-space samples in the central region **(102)** using an ordering other than a plane-by-plane ordering.

20. The magnetic resonance imaging apparatus as set forth in claim **18**, wherein the acquiring of k-space samples in the central region **(102)** includes:

acquiring k-space samples in the central region **(102)** using a random or pseudorandom ordering.

21. The magnetic resonance imaging apparatus as set forth in claim **20**, further comprising:

a display device **(68)** that displays each reconstructed plane image once the reconstruction processor **(62)** completes reconstruction of the corresponding k-space plane, without waiting for the reconstruction processor to reconstruct other k-space planes.

22. A magnetic resonance imaging apparatus comprising:

means for dividing k-space **(100)** into a central region **(102)** disposed at k-space center and one or more annular surrounding regions **(104, 106)** having increasing distances from k-space center, the one or more annular surrounding regions including an outermost surrounding region **(106)** having a largest distance from k-space center;

means for acquiring k-space samples in the k-space **(100)**, the k-space samples in the central region **(102)** being acquired first, the k-space samples in the outermost surrounding region **(106)** being acquired last, the k-space samples in at least the outermost surrounding region being acquired using a row-by-row data acquisition ordering in which

each row of k-space samples acquired in the outermost surrounding region completes a k-space plane; and

means **(62)** for reconstructing each completed k-space plane into a reconstructed image plane without waiting for all k-space samples in the outermost surrounding region **(106)** to be acquired.

23. The apparatus as set forth in claim **22**, wherein the acquiring means includes:

(i) means for acquiring a row of k-space samples by traversing secondary coordinate (c_s) positions in a positive direction at a first primary coordinate position (c_p);

(ii) means for applying a primary coordinate (c_p) magnetic field gradient to move to a second primary coordinate (c_p) position;

(iii) means for acquiring the second row of k-space samples by traversing secondary coordinate (c_s) positions in a negative direction at the second primary coordinate (c_p) position; and

(iv) means for repeatedly invoking the means (i), (ii), and (iii) to acquire a plurality of rows of k-space samples indexed by the primary coordinate (c_p).

24. The apparatus as set forth in claim **22**, wherein the acquiring means acquires at least the central region **(102)** using other than a row-by-row acquisition ordering, and the reconstructing means **(62)** includes:

means **(150)** for sorting k-space samples acquired in other than a row-by-row acquisition ordering into a row-by-row ordering.

25. The apparatus as set forth in claim **22**, wherein the reconstructing means **(62)** includes:

means **(150)** for organizing k-space samples of the completed k-space plane from the central region **(102)** and from the one or more annular surrounding regions **(104, 106)** into a k-space plane data set organized row-by-row;

means **(152)** for Fourier transforming each k-space sample of the completed k-space plane in a first direction to recover spatial content in the first direction; and

means (162) for Fourier transforming the k-space plane data set organized row-by-row in a second direction transverse to the first direction to recover spatial content in the second direction.